Fig. D Legend of Land Use Map

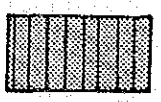
1. Settlements

Settlements

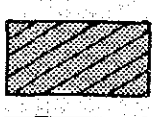
Urban Area

2. Agricultural Land

Permanent Crops — Wet Padi



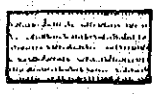
Rubber



Pepper

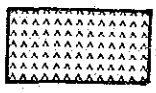
Oil Palm and Other Crops

Shifting Cultivation — Under Cultivation



Fallow Land

3. Secondary Forest



4. Forestland

5. Swamps, Unproductive Land and Clearings

Roads

Rivers

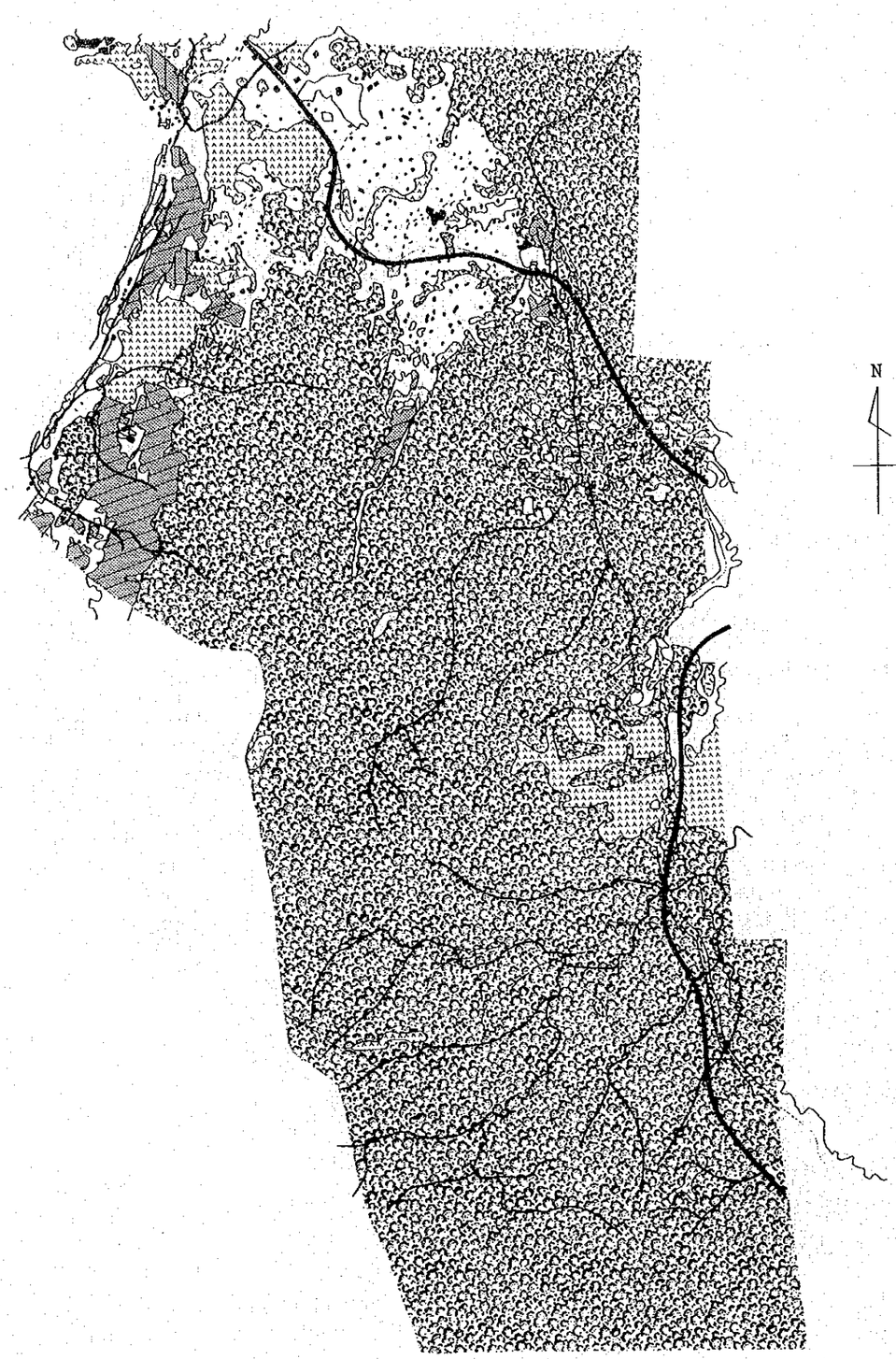


Fig. D-1 Land Use Before the Completion of the Road
(A Area)

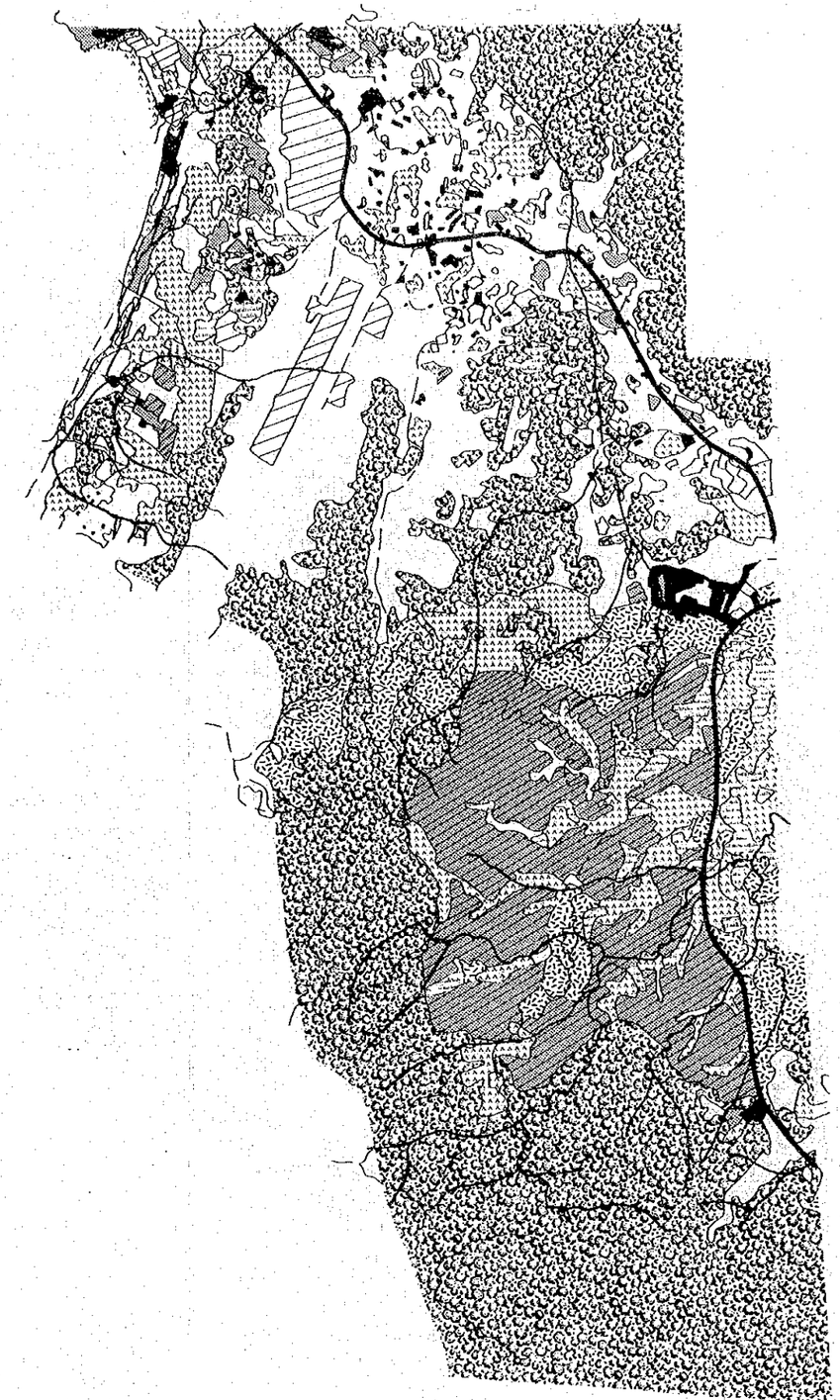


Fig. E-1 Land Use After the Completion of the Road
(A Area)

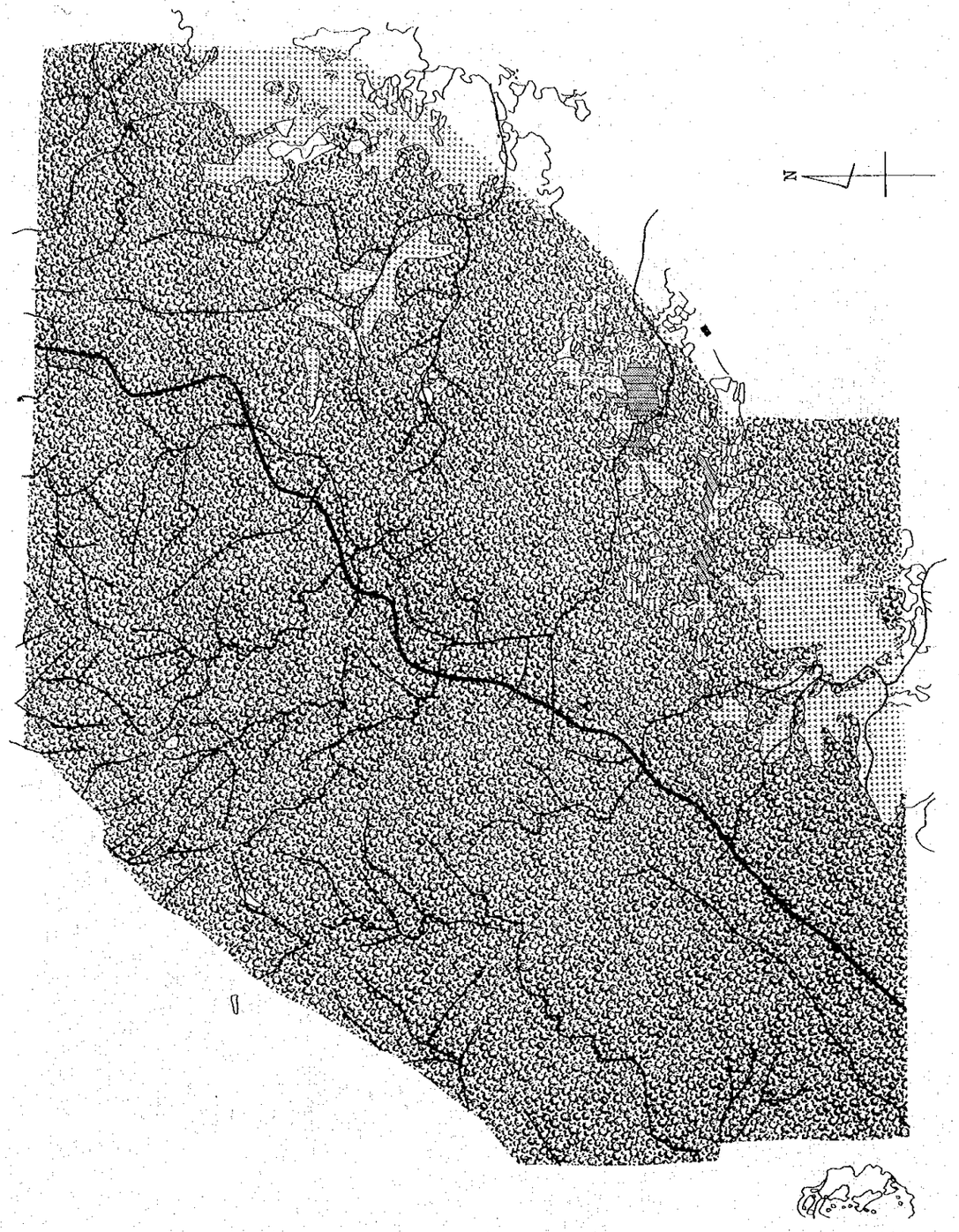


Fig. D-2 Land Use Before the Completion of the Road
(B Area)

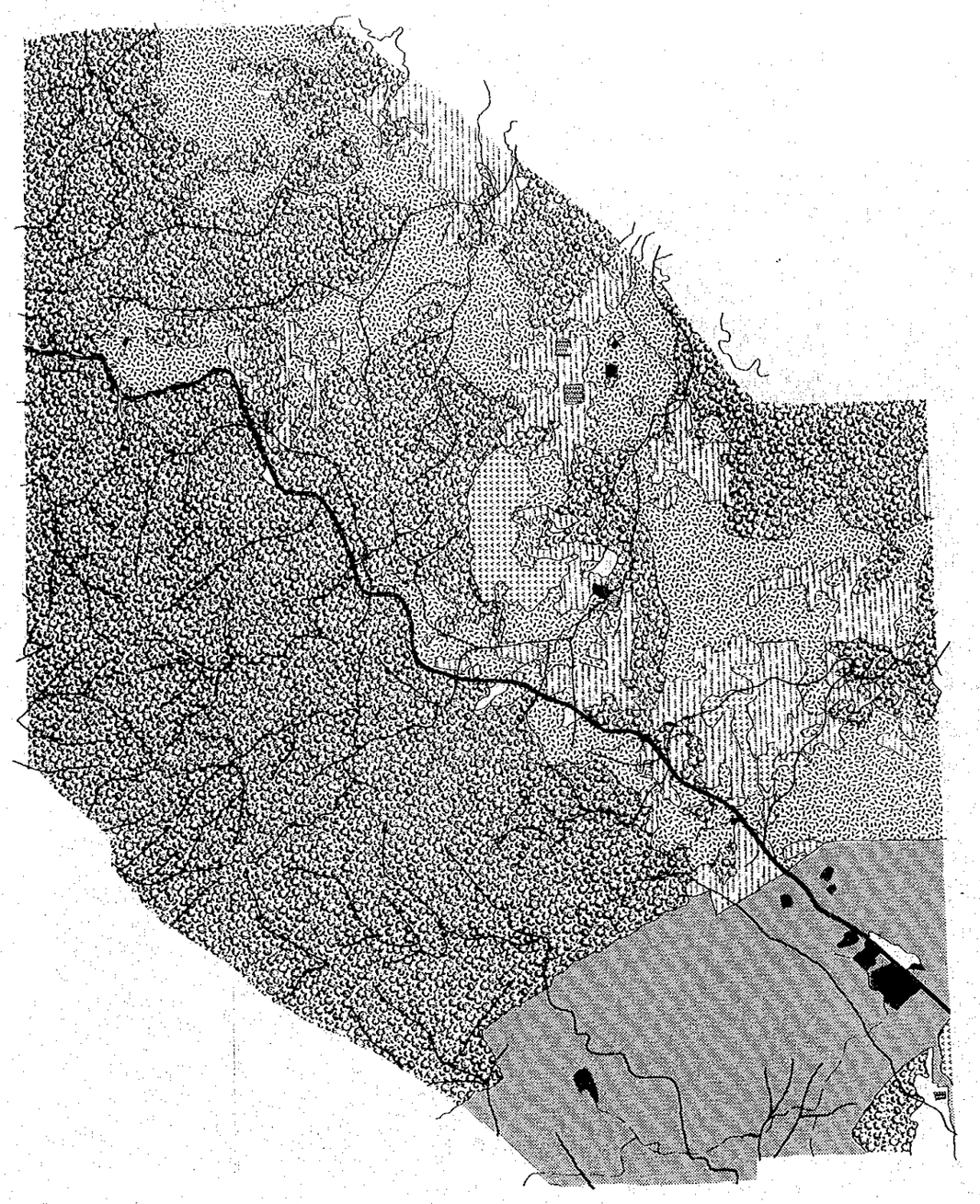


Fig. E-2 Land Use After the Completion of the Road
(B Area)

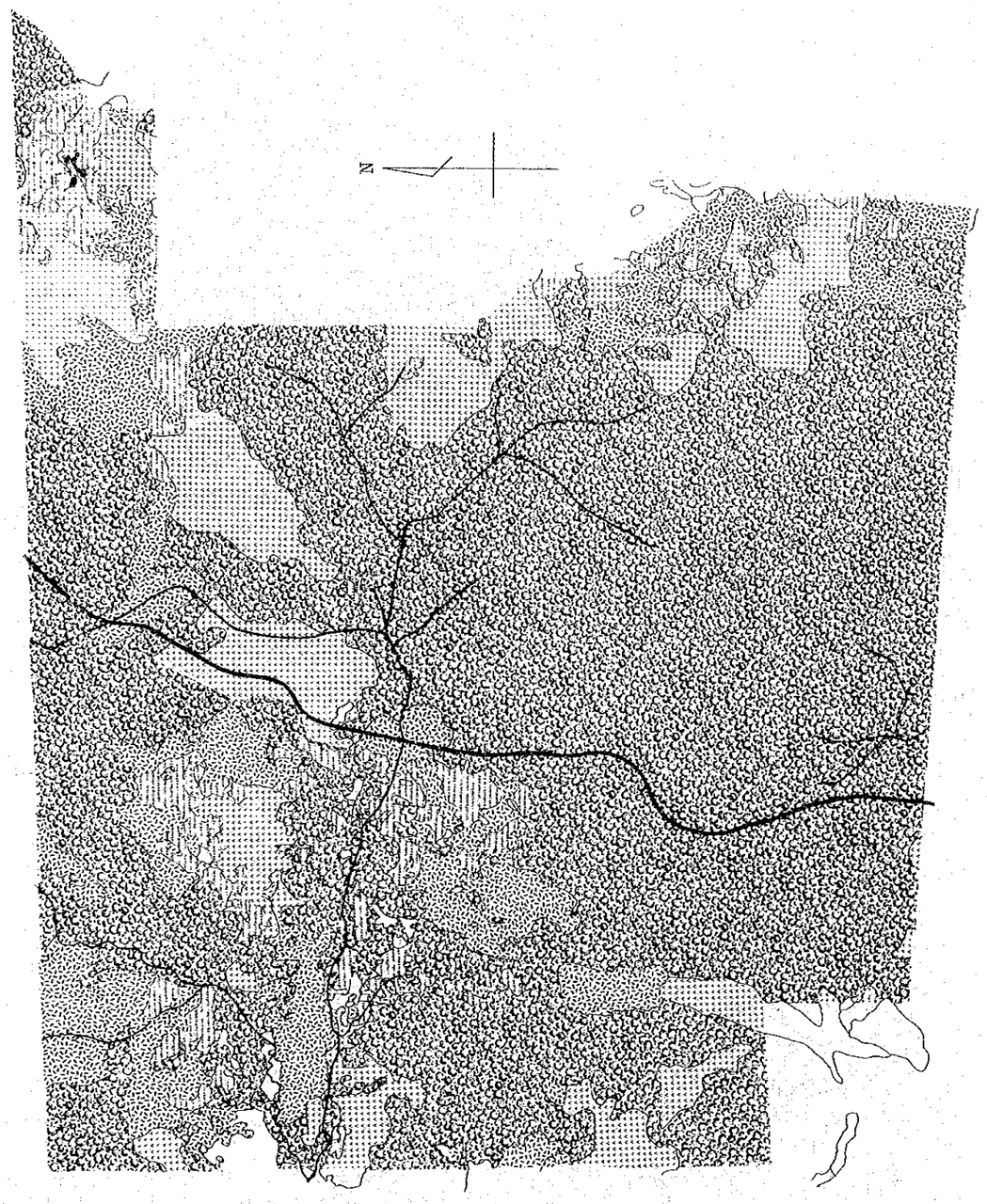


Fig. D-3 Land Use Before the Completion of the Road
(C Area)

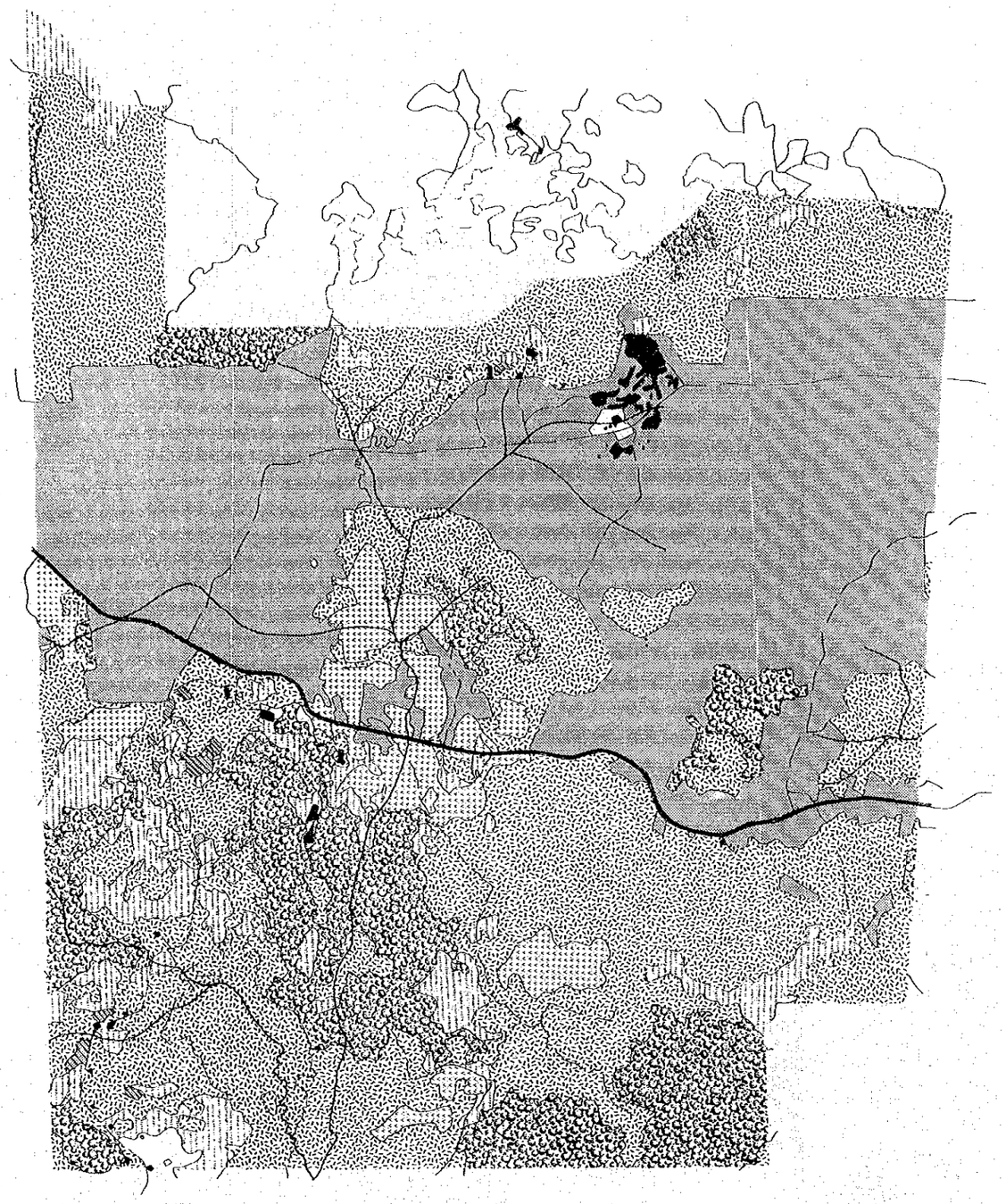


Fig. E-3 Land Use After the Completion of the Road
(C Area)

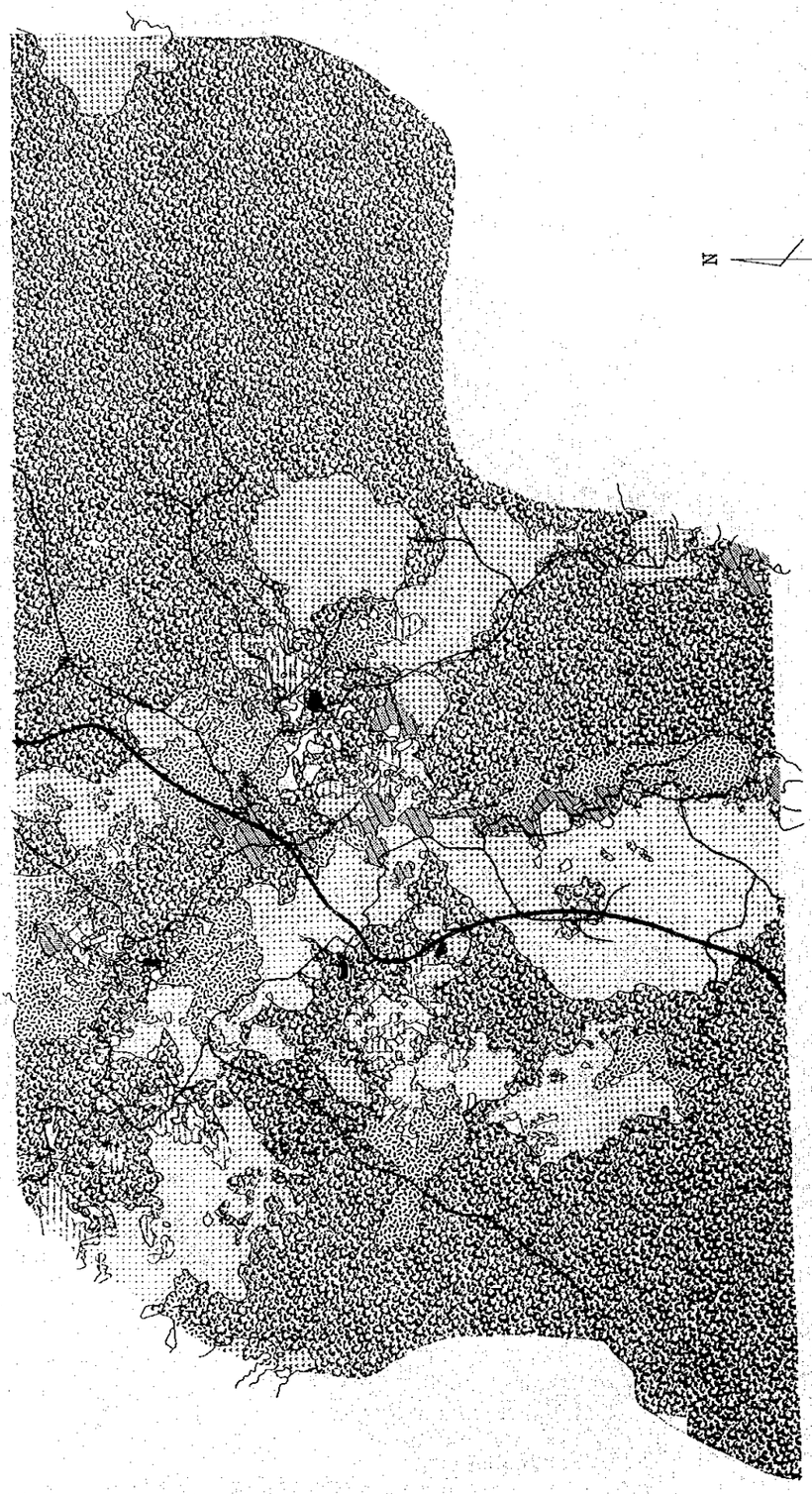


Fig. D-4 Land Use Before the Completion of the Road
(D Area)

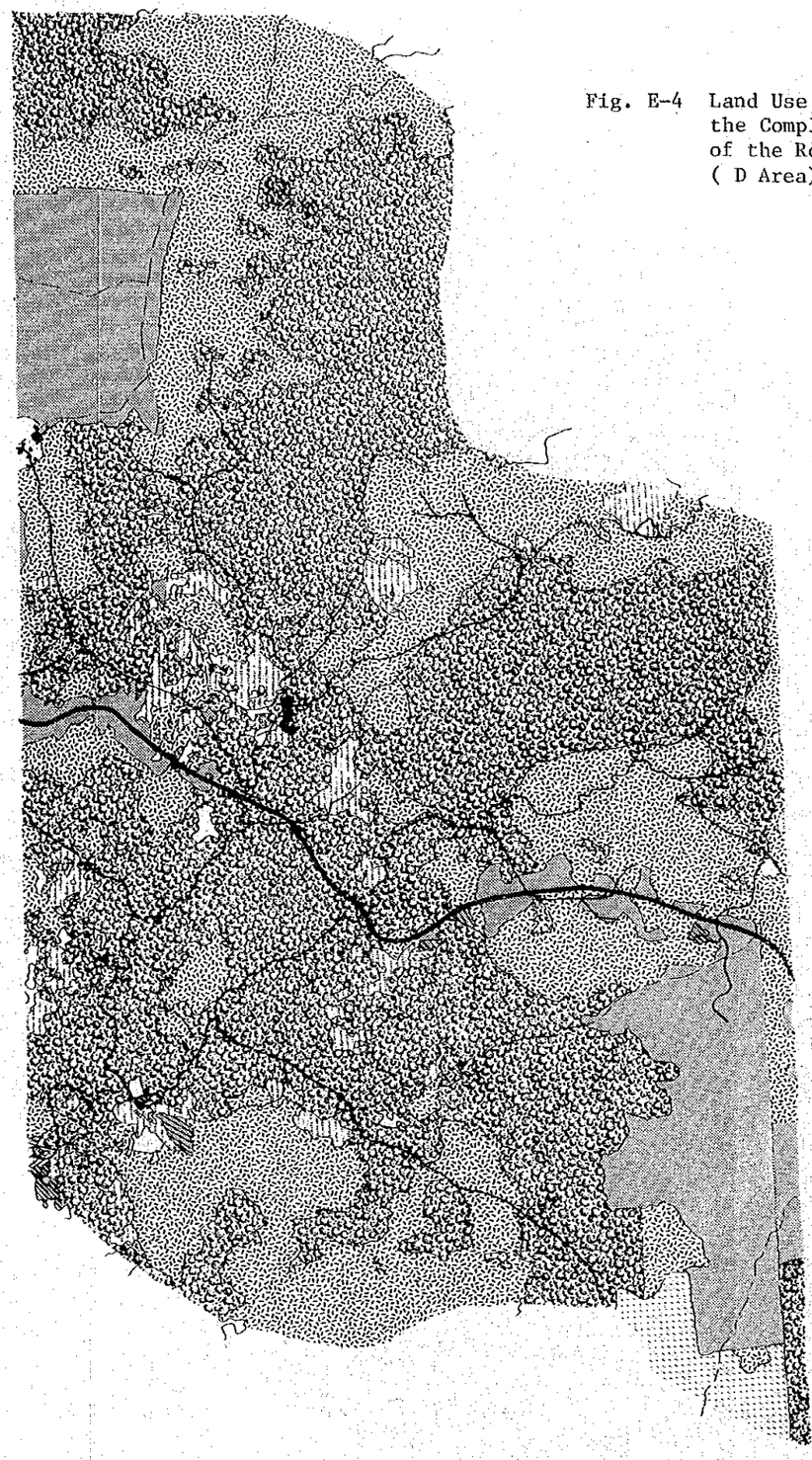


Fig. E-4 Land Use After the Completion of the Road
(D Area)

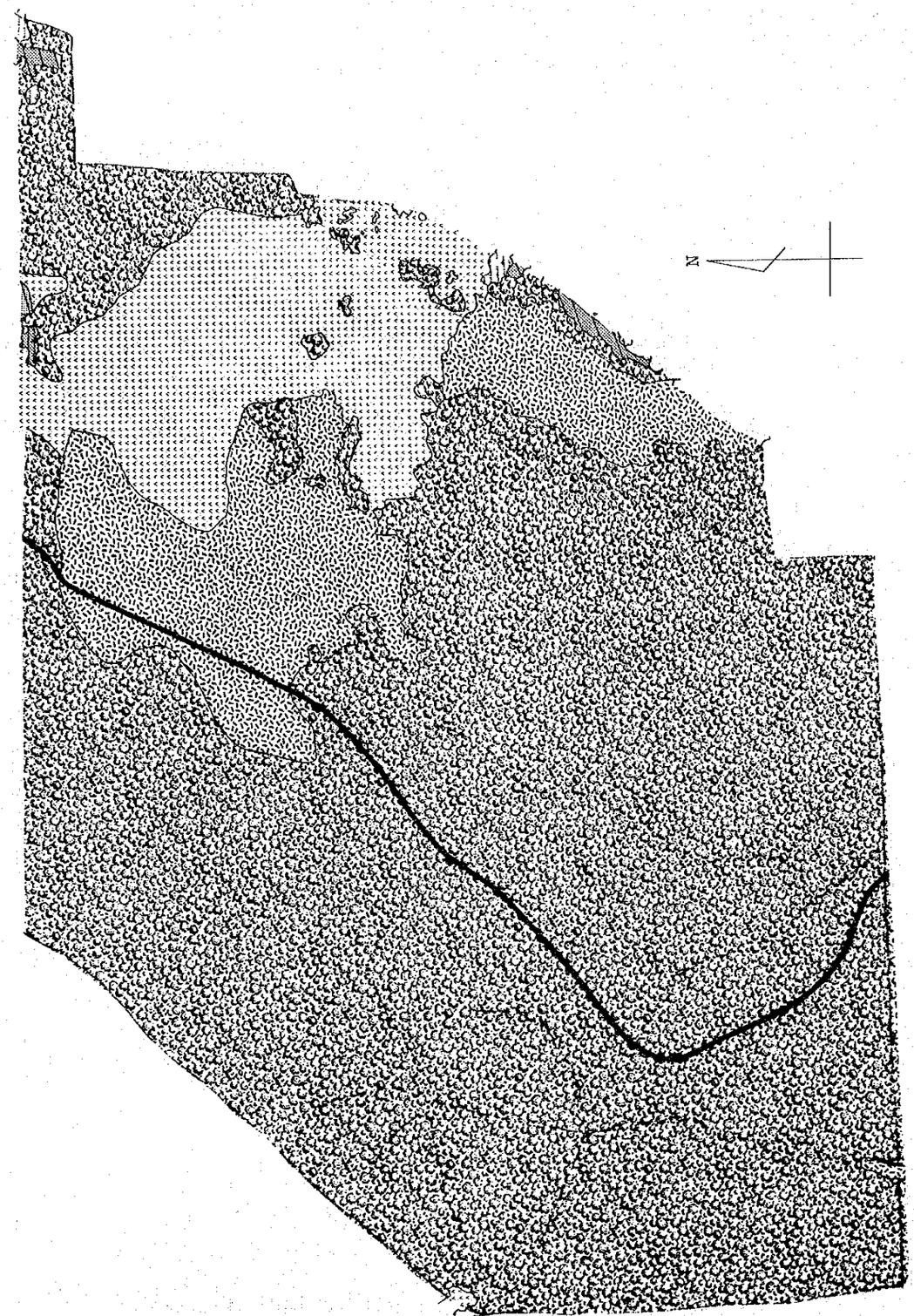


Fig. D-5 Land Use Before the Completion of the Road
(E Area)

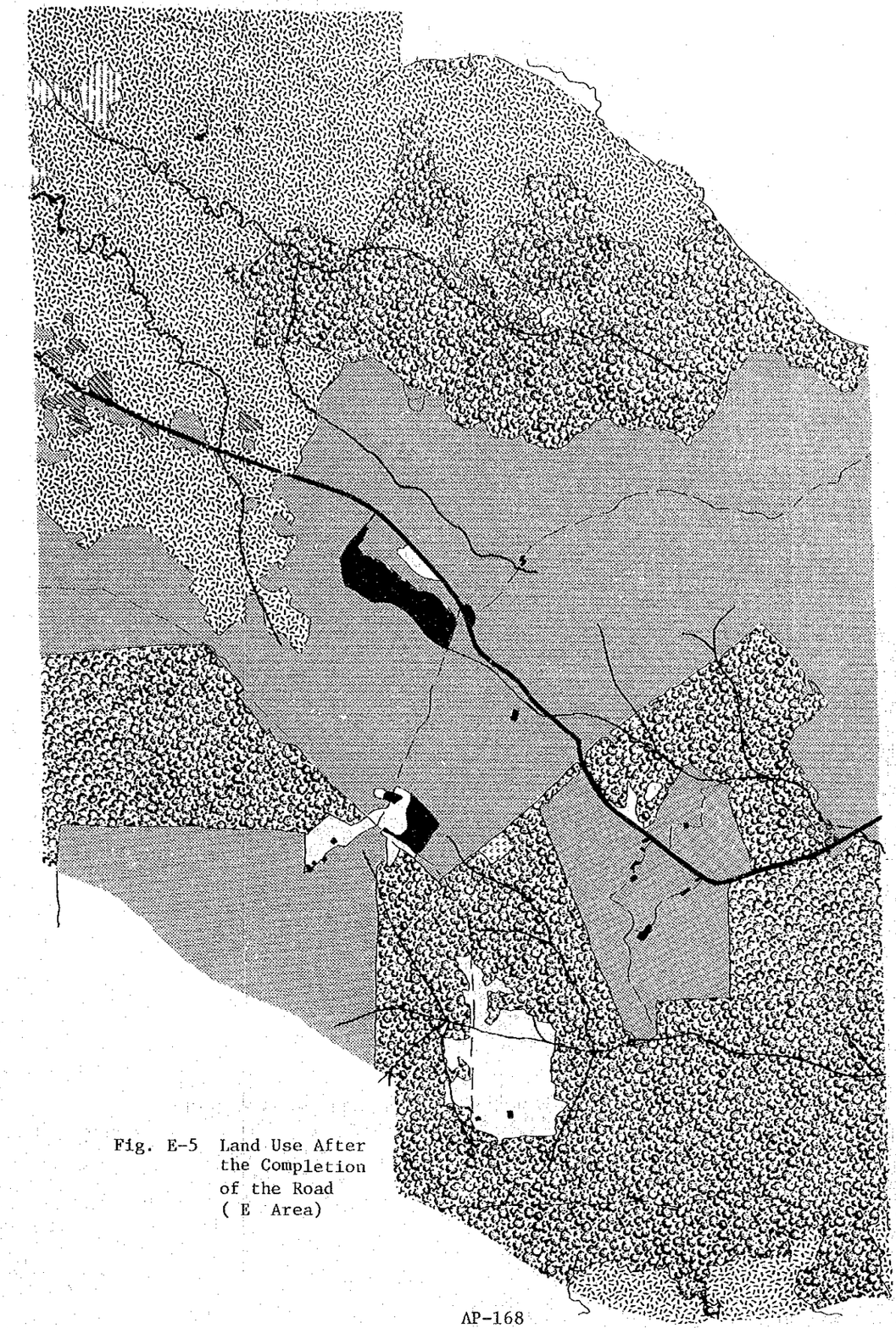


Fig. E-5 Land Use After the Completion of the Road
(E Area)

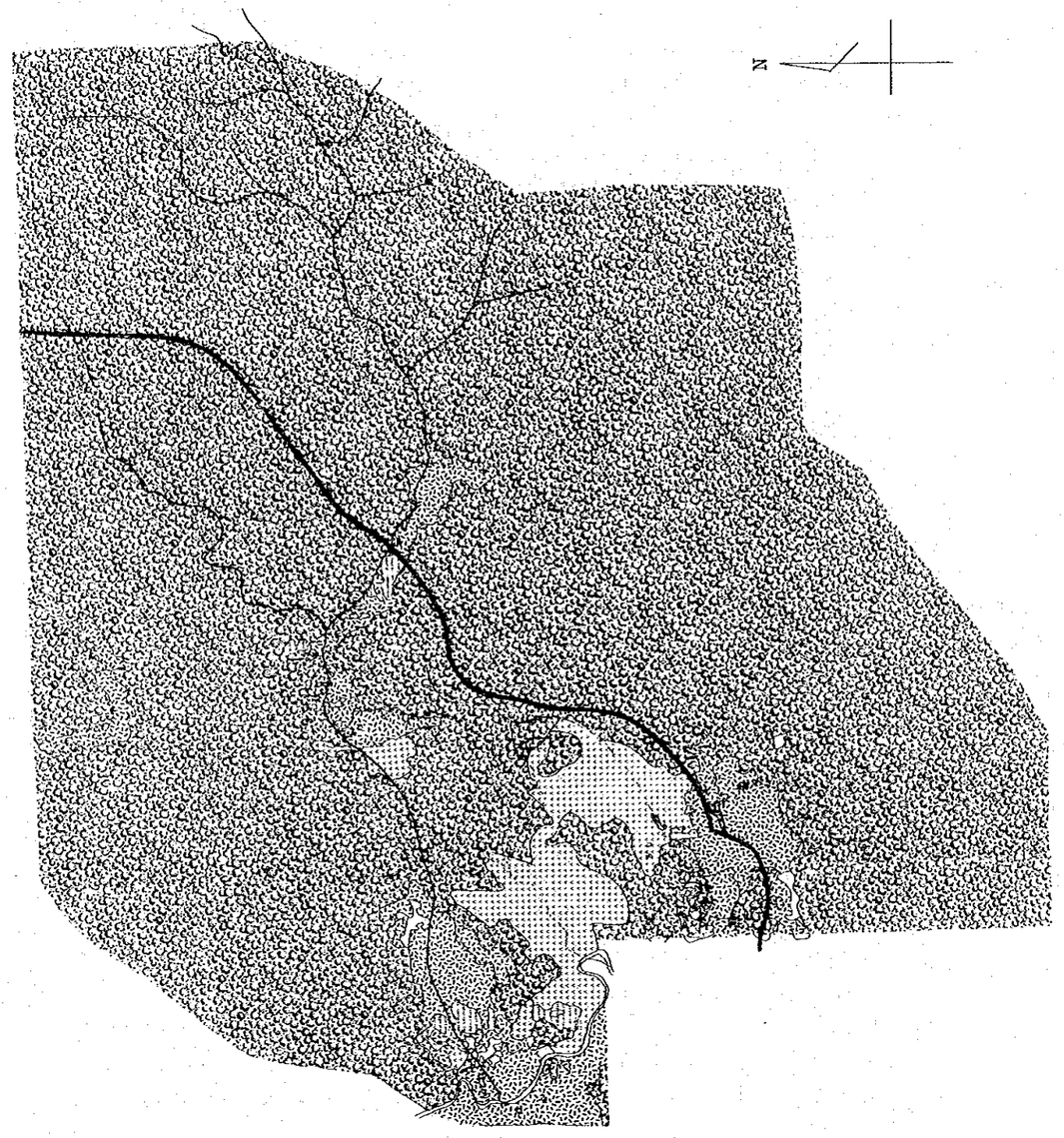


Fig. D-6 Land Use Before the Completion of the Road
(F Area)

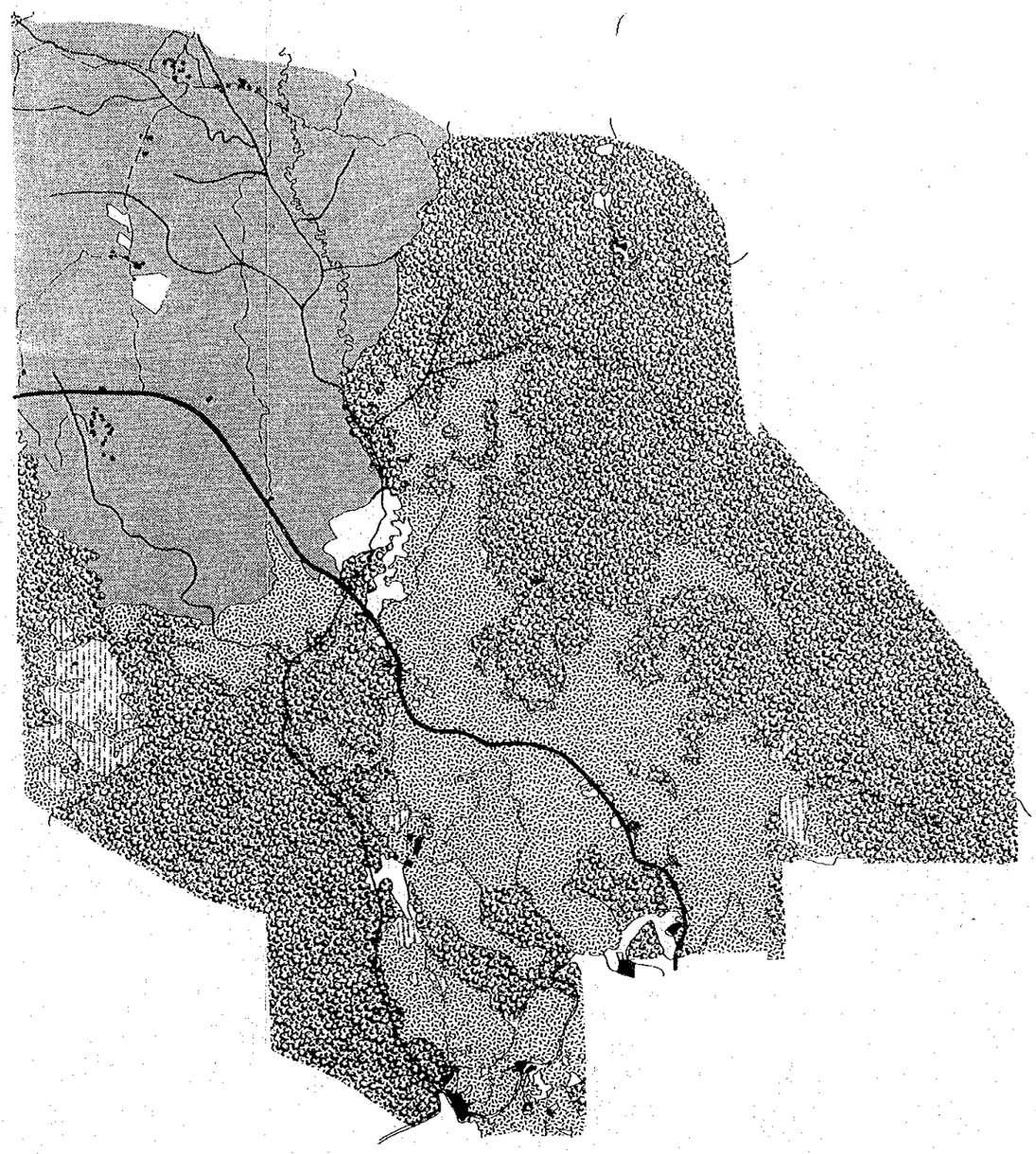


Fig. E-6 Land Use After the Completion of the Road
(F Area)

4. Agriculture

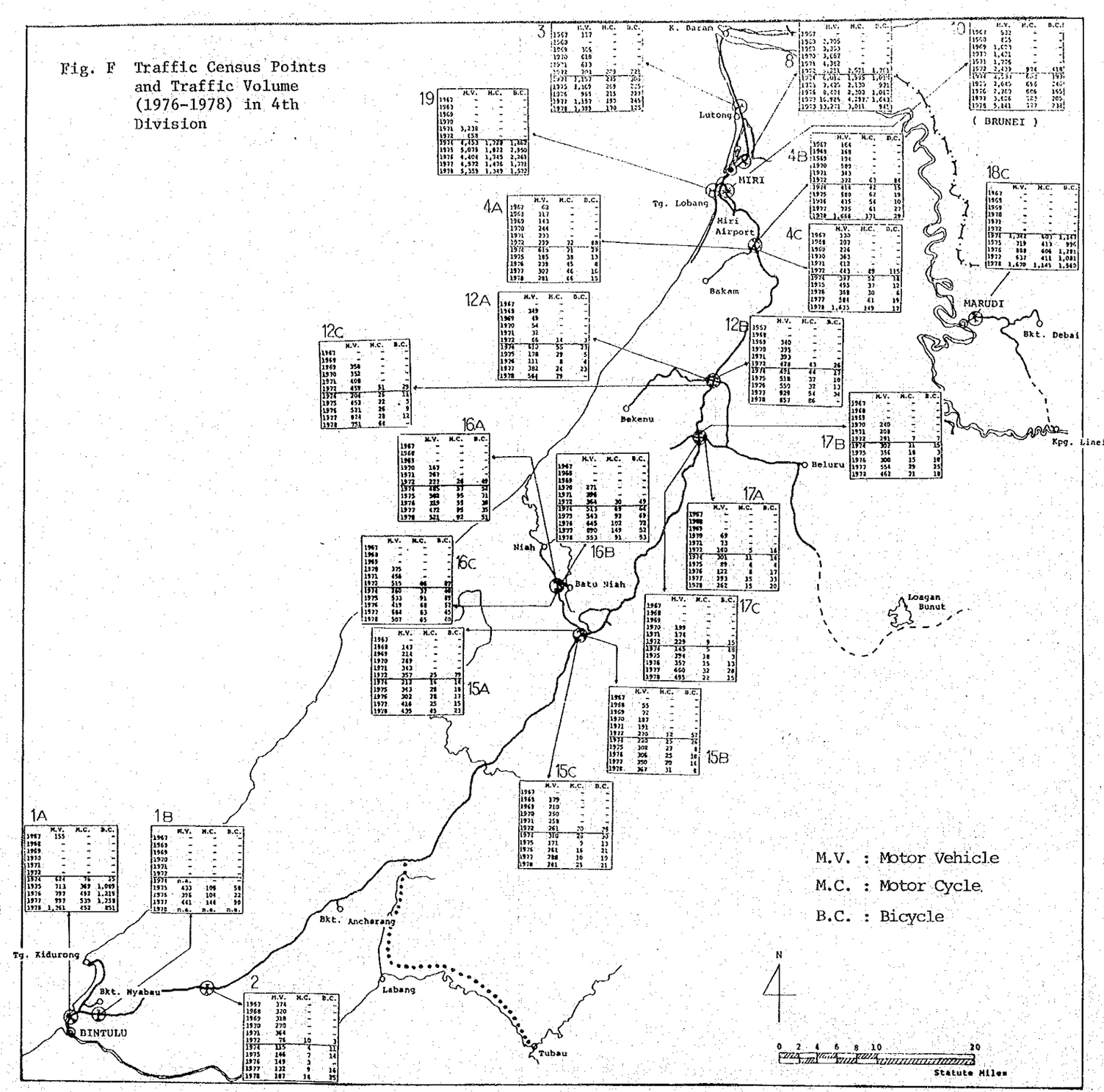
Rubber, pepper, wet paddy, and hill paddy are the major agricultural crops of the Study Area, whose production is expected to rapidly increase after the Road's completion. Rubber export quantity has increased from 2.57% of Sarawak's total (1965 - 1969 average) to 3.43% (1973 - 1977 average), while Marudi was replaced by Miri as the major port of rubber shipment. Export quantity of pepper started to rise rapidly in 1975/1976, after three years had passed after the Road's completion, reflecting the crops cultivation time (from planting to harvesting) of 30 to 36 months. Land in wet paddy slightly decreased from before to after the Road's completion (1968/69 - 1975/76), while harvest volume per unit of land increased by 1.7 times and the total harvest by 1.6 times. As shifting cultivation expanded, land in hill paddy increased by 1.3 times and its harvest volume per unit of land was somewhat improved, and, as a result, the total harvest of hill paddy increased by 1.5 times.

5. Socio-economic Changes in the Study Area

Traffic surveys have been taken since 1967, at the locations shown by Fig. F. Traffic volume showed steady increases both at locations at which traffic survey started before the opening of the Road and at locations at which the survey was started after the opening. The indicated development of road traffic has caused socio-economic changes to the Road-side inhabitants: The "Research Project on the Socio-Economic Impact of Roads in Sawarak (1977)" by the Nanyang University in Singapore and the International Development Research Center of Canada reported that the inhabitants' agricultural income rose very substantially and such public facilities as electric power and water supply improved. The greatest change was seen in trip mode: the sole reliance of both passenger and cargo transportation on river (boat) when no other alternative existed prior to the road construction shifted to major reliance on road (motorcycle, jeep, truck, bus, car) with the concurrent decline of water transportation to an insignificant level.

Saving in travel time by the use of a road as opposed to river is substantial; average travel time from four selected settlements to market was shortened from 59.77 minutes before to 21.09 minutes, or one-third, after the road completion. The reduction in time-distance to the market has resulted in higher frequencies of agricultural crops shipments and in greater revenues from cash crops such as rubber and pepper, as well as in more frequent shopping and recreational (motion picture theater) trips of the inhabitants.

Fig. F Traffic Census Points and Traffic Volume (1976-1978) in 4th Division



Appendix Note A-10-2

A Comparative Cost Analysis of Bg. Baram Crossing at Long Lama: Bridge vs. Ferry

1. Purpose

The purpose of this comparative cost analysis is to evaluate and compare the costs of crossing Bg. Baram at Long Lama by a bridge and by ferry and to determine the best method of crossing in terms of economy.

2. Necessary Ferry Facilities

The necessary ferry facilities include a pontoon, gangway, ferry boat, and land facilities. The number of ferry boats will depend on the traffic volume. One pontoon and gangway will be sufficient to accommodate one or two ferry boats, but additional facilities will be necessary to serve three or more ferry boats.

Table A shows the predicted future traffic volumes at the crossing point, whose hourly distribution is estimated based on the example of Miri/Bintulu area is shown on Table B. As indicated, it is estimated that the majority of traffic will occur in 12 hours from 6:00 to 18:00 and, therefore, it is believed desirable that the ferry will be operated for about 12 hours daily. If the ferry operation is limited to a 12-hour period daily, vehicles running at night will either wait for the beginning of ferry service in the morning or change their operational hours to conform with the ferry operation hours. Under such a situation, hourly traffic distribution will be as shown in Table C, along with distribution under a 10-hour ferry operation from 7:00 to 17:00 as sometimes is found in Sarawak.

The carrying capacity of each ferry boat is five passenger cars and three trucks, or, in terms of heavy vehicle equivalence (HVE), five. The time required for each round trip is about 10 minutes including loading and unloading time and, therefore, the ferry boat can make six round trips per hour and carry a total of 30 HVE's. However, the hourly distribution of vehicle arrivals at the crossing and local traffic situation in Long Lama town may not always allow for a capacity service to its capacity, and it is believed more realistic to assume the ferry's actual performance at the level of 80% capacity, or 25 HVE's per hour.

Table A Long Lama Crossing: Average Daily Traffic (ADT)

Year	Car/Taxi	Van/ pickup	Truck	Bus	Total	Total H.V.E 1/
1985	151	31	95	34	311	202
1995	320	86	190	73	669	425
2005	609	162	316	140	1,227	764

1/ H.V.E.= heavy vehicle equivalent
1 heavy vehicle = 2.5 light vehicles

Table B Long Lama Crossing: Hoursly Distribution of Traffic

Year	ADT	Total Traffic During Day Time (6am-6pm)	Total Traffic During Night Time (6pm-6am)	Average Hourly Traffic During Daytime Peak Hours (2 hours)	Average Hourly Traffic During Daytime Offpeak Hours (10 hours)
1985	202	176	26	18	14
1995	425	370	55	37	30
2005	764	664	100	66	53

Table C Long Lama Crossing: Distribution of Traffic*
Under 12-Hour and 10-Hour Ferry Operation

Year	ADT	Average Hourly Traffic 12 Hour Operation Peak Hours (2 hours)	12 Hour Operation Offpeak Hours (10 hours)	10 Hour Operation Peak Hours (2 hours)	10 Hour Operation Offpeak Hours (8 hours)
1985	202	21	16	25	19
1995	425	43	34	53	40
2005	764	76	61	96	72

Considering the volume and hourly distribution of traffic as shown on Table C above and the said ferry boat capacity (which will be 250 HVE's per day under 10-hour operation and 300 HVE's per day under 12-hour operation), it is believed that one ferry boat operated 10 hours daily (and, of course, 12 hours daily) will be sufficient in meeting the transportation demand of crossing traffic up to 1985. Exact time when a second ferry boat will become necessary depends on the level of service to be sustained, but, when hourly average traffic in the peak hours reaches 35 HVE's, vehicles will inevitably be kept waiting in line at the crossing or there will be a back up of uncarried vehicles at the end of each day's

operation (see Table E). The number of ferry boats required in the future is estimated on Table D.

Table D Estimated Number of Ferry Boats Required

Year	12-Hour Operation	10-Hour Operation
1985	1	1
1988	1	2
1990	2	2
1995	2	2
1998	2	3
2002	3	3
2005	3	4

Table E Traffic Volume and Waiting Conditions

(A) If average hourly traffic is 30 HVE's in peak hours and 23 HVE's in off-peak hours, waiting time will be negligible.

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Hourly Traffic (HVE)	23	30	23+5	23+3	23+1	23	23	30	23+5	23+3	23+1	23
Ferry's Hourly Carrying Capacity (HVE)	25	25	25	25	25	25	25	25	25	25	25	25
Back up of Un-carried Vehicles (HVE)	-	5	3	1	-	-	-	5	3	1	-	-

Continued

Table E Traffic Volume and Waiting Condition (Contd.)

(B) If average hourly traffic is 35 HVE's during peak hours and 26 HVE's during off-peak hours, there will be a back up of un-carried vehicles remaining at the end of each day's ferry operation in addition to the average waiting time of approximately one hour.

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Hourly Traffic (HVE)	26	35+1	26+11	26+12	26+13	26+14	26+15	35+16	25+26	26+27	26+28	26+29
Ferry's Hourly Carrying Capacity (HVE)	25	25	25	25	25	25	25	25	25	25	25	25
Back up of Un-carried Vehicles (HVE)	1	11	12	13	14	15	16	26	27	28	29	30

3. Ferry Service Cost

The cost of ferry service comprises the construction and maintenance costs of ferry facilities and operating cost of ferry boats.

a) Construction/Maintenance Costs of Ferry Facilities

Table F below summarizes construction and maintenance costs of the ferry facilities.

Table F Construction/Maintenance Costs of Ferry Facilities

Item	With Tax	Without Tax
(A) Construction Cost		
. Pontoon	M$338,000	
. Gangway	M$ 65,000	
. Land Facilities	M$491,000	
Total	M$894,000	M$804,600 [1]
(B) Maintenance Cost	M$ 44,700/Yr [2]	M$ 42,500/Yr [3]

Note for Table F:

1/ 90% of total construction cost with tax

2/ 5% of total construction cost

3/ 95% of maintenance cost with tax

Average annual cost of ferry facilities can be estimated based on the economic life of 15 years and the opportunity cost of capital of 8 percent per annum for capital investment as follow:

Annual cost of capital:

$$M\$804{,}600 \times \frac{0.08\ (1 + 0.08)^{15}}{(1 + 0.08)^{15} - 1} = M\$\ 94{,}000$$

Annual maintenance cost: M$ 42,500

Total Annual Cost of Ferry Facilities: M$136,500

b) Operating Cost of Ferry Boats

Based on the daily operation cost of ferry boat presented on Table H, average annual operation cost of ferry boat is estimated as follows:

Table G Average Annual Operation Cost of Ferry Boat (In M$'s)

ADT (HVE)	10-Hour Operation	12-Hour Operation
250	215,600	(237,600)
300	(349,000) 1/	247,600 2/

1/ Based on the addition of a ferry boat as needed.

2/ Assumes increase in the following operation time-dependent costs (50% each of depreciation and maintenance and 100% each of fuel, lubricant, and crew wages) as operation time is prolonged:

Depreciation	:	M$136/day x 0.5 x 0.2 = M$13.6/day
Maintenance	:	M$130.9/day x 0.5 x 0.2 = M$13.1/day
Crew Wages	:	M$193.9/day x 0.02 = M$38.8/day
Fuel	:	M$62.8/day x 0.2 = M$12.6/day
Lubricant	:	M$ 7.5/day x 0.2 = M$ 1.5/day
Overhead	:	10% of the totals of items hereabout M$8.0/day
Total		M$87.6/day

It is clearly seen from this Table that, when traffic increases, the operation time must be extended before an additional ferry boat is introduced.

Table H Operating Cost of Ferry Boat

(M$/day)

	Cost Item		"With" Project	"Without" Project
1.	Depreciation and Interest	Hull:	86.0	73.1
		Engine:	89.9	62.9
2.	Maintenance 2/		145.5	130.9
3.	Crew and Staff Wages		193.9	193.9
4.	Stores		6.1	5.8
	Sub-Total		521.4	466.6
5.	Fuel		64.4	62.8
6.	Lubricant		7.7	7.5
	Sub-Total		72.1	70.3
7.	Overhead		59.4	53.7
	Total		692.9	590.6

Source: Interviews with Local Ferry Operators

1/ Price New: Hull M$243,000 with tax, M$206,550 w/o tax
Engine M$199,000 with tax, M$139,800 w/o tax

Price New $\times \frac{i(1+i)}{(1+i)^n-1}$, $i = 8\%$, n = 15 years for Hull and 10 years for Engine

2/ Maintenance: Routine = M$ 3,000/year
Periodic = M$45,000/year

Maintenance cost with tax x 0.9 = maint. cost w/o tax

3/ Crew and Staff Wages per Shift:

Captain (1)	M$ 7,000/year
Operator (1)	M$ 6,000/year
Engineer (1)	M$ 6,000/year
Assistants (2)	M$ 7,000/year
Terminal Adm. (1)	M$ 6,000/year
	M$32,000/year

4/ Stores : M$2,000/year

5/ Fuel Consumption: Assuming that 10 hours operation per day of which engines are working 8 hours, fuel cost will be as follow:

5 gallon/hr x M$1.61/gallon (with tax) x 8 hrs
= M$64.40/day

6/ 12% of fuel consumption

7/ 10% of sub-totals

c) Total Ferry Service Cost

Based on a) and b) above, the average annual cost of ferry service is:

(1) When one ferry boat is in service (when ADT is 300 HVE's) ..... M$384,100

(2) When two ferry boats are in service (when ADT is 600 HVE's) ..... M$631,700

4. Bridge Cost

Assuming a bridge construction cost of M$4,760,000, economic life of 30 years, and an opportunity cost of capital of 8% per annum, average annual cost of bridge is calculated as follows:

$$M\$4{,}760 \times \frac{0.08\ (1 + 0.08)^{30}}{(1 + 0.08)^{30} - 1} = M\$\ 422{,}700/\text{Year}$$

Maintenance Cost: M$ 63,000/Year

Total: M$ 485,700/Year

5. Economic Analysis

As seen in the above, the average annual cost of ferry service by one boat (estimated at M$384,100) compares favorably with the average annual cost of bridge (estimated at M$485,700), but, when two ferry boats becomes necessary, bridge is to be preferred over two-boat ferry service (whose annual cost is estimated at M$631,700). Then, the use of one boat until such time when two boats will become necessary and the abolishment and replacement of ferry with a bridge at that time--which will be about 1990, or about five years from the commencement of ferry service--may be considered. However, if the boat is not directed to some other use and, therefore, must be scrapped at that time, it will have to be depreciated over five years, which will result in a higher one-boat ferry service cost than the bridge cost already in the initial five years.

6. Conclusion

It has been concluded, based on the above economic analysis and the following reasons, that a bridge is more desirable than ferry service:

a) The Baram River is a major shipment route of logs in the form of rafts, and the volume of log shipment is expected to increase in the future. If ferry service is to be utilized, its frequency will have to be increased in order to meet the expanding traffic demand. A consequence will be mutual hindrance between log rafts and ferry boat(s).

b) Local traffic volume between the existing Long Lama downtown and the area across the river, which is viewed as the only space for urban expansion, will increase in pace with the urban development.